

## IRL

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# Abel Jansma

## URL

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GitHub: [AJnsm](https://github.com/AJnsm)

I use machine learning, mathematics, and high-performance computing to understand emergent structures in complex systems. Experience in interdisciplinary teams at the interface of theory, experiment, and computation.

## EXPERIENCE

### Postdoctoral Fellow | University of Amsterdam | NL Nov 2024 - Present

- Received a 3-year fellowship from the Dutch Institute of Emergent Phenomena to study the foundations and applications of emergence and higher-order structure in complex systems.
- Affiliated to the Institute of Physics (IoP) and the Institute for Logic, Language and Computation (ILLC).

### Postdoctoral Researcher | Max Planck Institute for Mathematics in the Sciences | GER Sep 2023 - Sep 2024

- In the groups of Jürgen Jost and Bernd Sturmfels, I worked on higher-order information theory, (quantum) generative machine learning, and applications to biology.
- Affiliated with Quantum Informatics at the University of Edinburgh to study parametrised quantum circuits.
- Deployed quantum machine learning code on QVMs (pyQuil, Qiskit) and QPUs (AWS Braket).

### Postdoctoral Researcher | University of Edinburgh | UK Oct 2022 - July 2023

- Combined generative models, statistical physics, and causal inference to construct hypergraphs of genetic interactions and discovered novel and rare cell identities in populations of up to 100k transcriptomes.
- Inventor and lead R&D of the **STATOR** software package, in an interdisciplinary team across physics, biology, and informatics, combining fundamental research with biomedical applications.

### Information Officer | SciPost | NL Oct 2017 - July 2018

- Expanded the editorial board, profiling and contacting potential new editors.

### Junior Editor | SPUI25 | NL Feb 2017 - July 2017

- Co-organised and presented monthly academic & cultural events for a broad audience.

### Distillation Engineer | Mediamatic | NL Sep 2016 - Feb 2017

- Designed, built, and demonstrated a bespoke 30 litre vacuum still for artistic and olfactory research.

## EDUCATION

### PhD in Biomedical AI | University of Edinburgh | UK Sep 2018 - Dec 2022

- Thesis: *Higher-order interactions in single-cell gene expression: Towards a cybergenetic semantics of cell state*
- Supervised by C. Ponting (Genetics and Cancer), L. Del Debbio (Physics), and A. Khamseh (Informatics).
- Graduated from the *Academy for PhD Training in Statistics* at the universities of Cambridge and Oxford.

### MSc Theoretical Physics | University of Amsterdam | NL Sep 2015 - July 2018

- Thesis:  *$E_8$  symmetry structures in the Ising model* (supervised by B. Nienhuis)
- Visited the Niels Bohr Institute in Copenhagen, Denmark (Feb to Aug 2016), to study nonequilibrium physics and the physics of machine learning.

### BSc Physics and Astronomy | University of Amsterdam | NL Sep 2012 - July 2015

- Graduated with Honours/Cum Laude and a minor in Computational Science.

### Propeduse in Art and Technology | HKU University of the Arts | NL Sep 2011 - July 2012

- Art installations on collective behaviour, exhibited in galleries & festivals in the Netherlands, Germany, and Finland.

## SELECTED PUBLICATIONS & TALKS

### Articles

- A Mereological Approach to Higher-Order Structure in Complex Systems: from Macro to Micro with Möbius - Jansma, A (Physical Review Research, 2025)
- Decomposing Interventional Causality into Synergistic, Redundant, and Unique Components - Jansma (2025)
- High Order Expression Dependencies Finely Resolve Cryptic States and Subtypes in Single Cell Data - Jansma et al. (Molecular Systems Biology, 2025)
- The Fast Möbius Transform: An algebraic approach to information decomposition - Jansma et al (2024)
- Superdense Coding and Stabiliser Codes with Ising-coupled Entanglement - Jansma, A (2024)
- Higher-Order Interactions and Their Duals Reveal Synergy and Logical Dependence beyond Shannon Information - Jansma, A (Entropy, 2023)
- A Compositional Game to Fairly Divide Homogeneous Cake - Jansma, A (2023)

### Conferences

- Higher-order in-and-outeractions - DEMICS23, GER, 2023 (talk)
- A compositional game to fairly divide homogeneous cake - Applied Category Theory 2023 (poster)
- Model-free estimation of higher-order interactions - CSHL Biology of Genomes conference, USA, 2021 (poster)
- Higher-order interactions in single-cell expression data - European Mathematical Genetics Meeting, FR, 2021 (talk)
- Higher-order interactions in single-cell expression data - CSHL Network Biology conference, USA, 2021 (poster)

### Invited Talks

- From Macro to Micro with Möbius - UvA Institute for Advanced Studies, NL, 2025
- A Compositional approach to higher-order structure in complex systems - Imperial College London, UK, 2024
- A unified approach to higher-order structure in complex systems - University of Leipzig, GER, 2024
- The information theory of higher-order interactions - UvA Institute for Advanced Studies, NL, 2023
- Complex networks in the mouse brain - IGC Biomed. Genomics, UK, 2021
- Searching for strange loops in mouse brains - Math. Quantum Physics Seminar, University of Innsbruck, AT, 2021
- Higher-order information lattices - Math. Quantum Physics Seminar, University of Innsbruck, AT, 2021

## HONOURS & AWARDS

### Protocol Fellowship Grant | Ethereum Foundation | GER

Nov 2022 - March 2023

- Research grant in collaboration with the Robust Incentives group and the Institute for Categorical Cybernetics.

### Science Communication Grant | Genetics Society | UK

April 2019

- One of 10 (post-)doctoral researchers nationwide to be awarded funding for science communication training.

### Technology Scholarship | ASML | NL

Sep 2015 - Sep 2017

- One of 25 graduate students nationwide awarded a two-year professional development scholarship.

## VOLUNTEERING

### Co-host | Computational Biology Journal Club

Feb 2019 - March 2020

### Beekeeper | Anna's Tuin en Ruigte

Oct 2017 - July 2018

### Reader | VoorleesExpress

Nov 2016 - Nov 2017

- I read books to children to stimulate language development and promote reading.

### Committee member | BetaBreak

Dec 2014 - Jan 2016

- Moderated and organised public debates on science & society at Amsterdam Science Park.

## LANGUAGES

### Natural

Dutch (native), English (fluent), German (fluent), French (basic)

### Programming

Python (SciPy, PyTorch, Qiskit, *etc.*), R, Nextflow, SGE, Git, Haskell, Arduino (C++)